

## Chapter 5

## **5.0 CONCEPTUAL DESIGN AND PRELIMINARY COST ESTIMATE FOR A FULL-SCALE MICROFILTRATION APPLICATION**

### **5.1 DEVELOPMENT OF HYDRAULIC AND TOTAL PHOSPHORUS DESIGN CRITERIA**

The consulting firms of PEER Consultant and Brown and Caldwell, jointly developed a standard of comparison for all supplemental technology demonstration projects (PEER Consultants/Brown and Caldwell, J.V., November 1997; PEER Consultants/Brown and Caldwell, J.V., August 1999). A process identified as the Supplemental Technology Standard of Comparison (STSOC) was established to enable SFWMD to compare supplemental technologies. Flow and total phosphorus data used in developing facility conceptual designs are required, by the standard of comparison guidelines, to be developed from the 10-year period of record (POR) baseline data used for preparing the detailed design for STA.

Generating this synthetic daily time series of inflow and outflow phosphorus information was based upon rescaling historical S5A and S6 flows and phosphorus loadings. Documentation received with this data indicated the following factors were ignored in developing this time series summary:

- BMP make-up water contributions to STA 2 (October – February time period);
- Attenuation of inflow concentration peaks due to STA storage and uptake; and
- Atmospheric phosphorus loads.

The program documentation also indicates that the effect of recently implemented BMPs in the EAA is accounted for by reducing the baseline historical phosphorus concentrations by 25 percent. Input assumptions (as described in the program documentation) made in creating these summaries included:

- The STA average outflow concentration will be equal to 50 ppb of phosphorus;
- The BMP load reduction, as indicated above, is equal to 25 percent; and
- The fraction of S5A flow diverted to STA 2 was equal to 0.163.

The period of record for the data series is from 1/1/79 through 9/30/88. The historical flow weighted mean total phosphorus concentration for this period was equal to 163.1 ppb for S6 plus an additional 16.3 percent of S5A. The computed STA inflow mean phosphorus concentration was equal to 122 ppb for the 9.75-year period of record.

### **5.2 DEVELOPMENT OF CONCEPTUAL DESIGNS FOR FULL-SCALE POST-BMP AND POST-STA TREATMENT FACILITIES**

#### **5.2.1 Analysis of the Baseline Period of Record Data and its Application to the CT-SS Conceptual Design**

**FIGURE 5.1** provides a graphical representation of the baseline STA 2 inflow data for the 10-year POR and **FIGURE 5.2** shows the corresponding phosphorus concentrations for the same time period. The average flow is equal to 1,424-acre - feet (464 million

gallons per day) of water per day. Also shown on **FIGURE 5.1** are the mean plus 1, 2, and 3 standard deviations of the flow data, respectively.

**FIGURE 5.3** provides the graph of the estimated Post-STA 2 effluent flow for the 10-year POR. **FIGURE 5.4** shows the corresponding phosphorus concentration values for this same time period. The average Post-STA flow is equal to 536-acre - feet per day (175 million gallons per day). **FIGURE 5.3** also shows the mean flow plus one, two and three standard deviations, respectively.

Based on the STSOC guidelines, six full-scale facility scenarios were developed each for Post-BMP and Post-STA applications. These facilities were designed to achieve flow weighted average effluent TP concentrations of 10 and 20 ppb TP with 0%, 10%, and 20% flow diversion (STSOC required) of the 10-year POR flow volume. This approach resulted in a total of 12 full-scale treatment scenarios, shown below.

Location	Effluent TP	No Diversion (MGD)	10% Diversion (MGD)	20% Diversion (MGD)
Post – BMP	10 ppb	380	270	200
	20 ppb	220	150	190
Post - STA	10 ppb	390	260	100
	20 ppb	140	100	80

## 5.2.2 Full-Scale Conceptual Design Fundamental Approach

Water treatment technologies generally operate best (*e.g.*, consistently produce the highest quality effluent stream) within a relatively narrow range of influent flows. The wide fluctuations of flows associated with the EAA stormwaters will require full-scale conventional water treatment systems to be coupled with flow equalization basins (FEB) in order to store runoff from peak rainfall events until they can be adequately processed. For the purposes of this report, flow equalization was accomplished within the STA and treatment plant sizes were determined for each POR flow diversion scenario to meet the desired effluent quality. Water balances were completed to determine the treatment plant sizes. The assumptions and the basis for them are summarized below.

### (1) ***Post-BMP Treatment System:***

- Flow equalization, chemical treatment, residual solids thickening, and final buffer cell conditioning will occur within the foot print of the existing STA-2;
- 6,000-acres of STA-2 will be used as a FEB. The levees will not be modified and will be used to store water up to 4.5 feet;
- Bypass occurs when the FEB has reached capacity;
- Rainfall and evapotranspiration from FEB have been neglected (Walker, 50-yr POR);
- The phosphorus removal rate within the FEB is 20% (Walker/ Kadlec);
- The full-scale CT-SS system can operate at a peak load of 50 percent greater than its average daily design flow rate for limited time periods (HSA);

- The CT-SS technology coupled with ferric chloride addition will produce an average clarified effluent total phosphorus concentration of at least 0.006 mg/L as P. This concentration was calculated using the Demonstration period clarifier effluent concentrations (ENR Influent Location). Several of the TP concentrations were below the laboratory detection limit (0.004 mg/L). These data were used in the calculations using the detection limit as the TP concentration. This approach is conservative and the actual full-scale system will probably produce filtrates with lower Total P results;
- Raw untreated water would be blended with the CT-SS effluent to achieve the desired discharge concentration (0.01 or 0.02 mg/L as P), STSOC; and
- Full-scale treatment scenarios were based on a scale-up of the CT-SS pilot data.

**TABLE 5.1** presents the detailed conceptual design criteria developed for the Post-BMP CT-SS facility designs. These conceptual designs were developed from scale up values from the CT-SS pilot facility as it was successfully operated during demonstration testing.

(2) ***Post-STA Treatment System:***

- “Natural treatment”, flow equalization, chemical treatment, residual solids thickening, and final buffer cell conditioning will occur within the framework of the existing STA-2. Based on the pilot data, it was determined that the CT-SS treatment process could treat Post-STA water with an outflow TP concentration of 65 ppb.
- The required size of STA-2 (acres) to provide an effluent TP concentration of 65 ppb was estimated using the exponential relationship between the STA-2 area and the outflow TP concentration represented by,  $C = C_o * e^{-kA}$ , where C is the outflow concentration,  $C_o$  is the inflow concentration, K is a constant and A is the STA area (Kadlec, Walker). Using the assumed inflow concentration (122 ppb) and the outflow concentration (50 ppb), the exponential relationship becomes,  $50 = 122e^{-kA}$ . If the CT-SS plant can treat post-STA water with an outflow concentration of 65 ppb, a 4,540-acre “natural system” is required.
- The Post-STA full-scale conceptual design uses Cell No. 3 and No. 2 of STA-2 (combined area of 4,440 acres) as a “natural system”.
- 1,500-acres of STA-2 will be used as a FEB. The levees will not be modified and will be used to store water up to 4.5 feet.
- Bypass occurs when the FEB has reached capacity.
- Rainfall and evapotranspiration from FEB have been neglected (Walker, 50-yr. POR).
- The phosphorus removal rate within the FEB is 20 percent (Walker, Kadlec).

- The full-scale CT-SS system can operate at a peak load of 50 percent greater than its average daily design flow rate for time periods.
- The CT-SS technology coupled with alum addition will produce an average clarified effluent total phosphorus concentration of at least 0.006 mg/L as P. This concentration was calculated using the Demonstration period clarifier effluent concentrations (ENR Effluent Location). Several of the TP concentrations were below the laboratory detection limit (0.004 mg/L). These data were used in the calculations using the detection limit as the TP concentration. This approach is conservative and the actual full-scale system will probably produce filtrates with lower Total P results.
- Raw untreated water would be blended with the CT-SS effluent to achieve the desired discharge concentration (0.01 or 0.02 mg/L as P).
- Full-scale treatment scenarios were based on a scale-up of the CT-SS pilot data.

**TABLE 5.2** presents the detailed conceptual design criteria developed for the Post-STA CT-SS facility designs.

A schematic for the full-scale facility conceptual design is shown on **FIGURE 5.5**.

### **5.2.3 Post-BMP Full-Scale CT-SS Treatment System Conceptual Design**

The Post-BMP conceptual design scenarios were based on using 6,000-acres of the STA for flow equalization and the remaining 430 acres for the treatment plant works, residual solids thickening, and treated water conditioning using a buffer cell. The existing influent STA pump station would pump the water into the flow equalization basin (FEB), former STA, and a new pump station would be installed to pump the water from the equalization basin into the treatment plant.

Post-BMP waters would be pumped into concrete basin coagulators where ferric chloride is fed at an average dose of 40 mg/L as Fe. Coagulated water flows into concrete flocculation basin where an anionic polymer is fed into the system at an average dose of 0.5 mg/L. The water is then clarified in concrete basins equipped with lamella plate settlers. The treated water flows into a buffer cell then into a collection canal. The existing effluent STA pumping station would be used to discharge the treated water into the conservation area.

Residual solids will be discharged to an onsite storage lagoon, using a residual solids hydraulic detention time of three days. Supernatant overflow from the solids storage area would be returned to the FEB for treatment. Settled solids in the lagoon are pumped to a dedicated land application facility. The estimated required area for this dedicated solids disposal area ranges from 1,150 to 1,680 acres and is based upon an annual solids loading criterion of 28 tons of dry solids per acre per year (USEPA, 1995).

The six full-scale Post-BMP conceptual design scenarios are summarized below.

<b>Post-BMP Conceptual Design Summary</b>		
<b>Effluent TP Concentration</b>	<b>Diversion of 10-yr POR</b>	<b>Treatment Plant Design Average Daily Flow (mgd)</b>
10 ppb	No diversion	380
	10 %	270
	20 %	200
20 ppb	No Diversion	220
	10 %	150
	20%	120

The existing levees would be operated using a maximum water height of 4.5 feet, allowing for four feet of water storage (0.5 to 4.5 feet). The treatment plant would operate at a peak load of 50 percent greater than its average daily design flow rate when the water level within the equalization basin reached 3.5 feet. The table below summarizes the Post-BMP treatment plant operation data and the corresponding FEB water level.

<b>Post-BMP Treatment Plant Operation Summary</b>				
<b>Treatment Plant Size (mgd)</b>	<b>% operation During 10-yr POR</b>	<b>% operating time at peak design flow rate</b>	<b>Average depth in FEB (feet)</b>	<b>Days exceedance of 4.0 feet (days/Yr)</b>
380	38	16	1.1	10
270	48	17	1.2	15
200	56	18	1.4	21
220	56	24	1.5	31
150	71	25	1.9	44
120	77	29	2.1	51

#### **5.2.4 Post-STA Full-Scale CT-SS Treatment System Conceptual Design**

The Post-STA conceptual design scenarios were based on using 4,400-acres of STA-2 as a “natural system”. The natural system would produce an average effluent TP concentration of 65 ppb. Flow equalization would occur in a 1,500-acre basin and the remaining 530 acres for the treatment plant works and buffer cell. The existing influent STA pump station would pump the water into the STA for natural treatment. A new pump station would be installed to pump the naturally treated water into the FEB. Another new pump station would be installed to pump the water from the equalization basin into the treatment plant.

Post-STA waters would be pumped into concrete basin coagulators where alum is fed at an average dose of 20 mg/L as Al. Coagulated water flows into concrete flocculation basin where an anionic polymer is fed into the system at an average dose of 0.5 mg/L. The water is then clarified in concrete basins equipped with lamella plate settlers. The

treated water flows into a buffer cell then into a collection canal. The existing effluent STA pumping station would be used to discharge the treated water into the conservation area.

Residual solids will be discharged to an onsite storage lagoon, using a residual solids hydraulic detention time of three days. Supernatant overflow from the solids storage area would be returned to the FEB for later treatment. Settled solids in the lagoon are pumped to a dedicated land application facility. The estimated required area for this dedicated solids disposal area ranges from 450 to 910 acres and is based upon an annual solids loading criterion of 28 tons of dry solids per acre per year (USEPA. 1995).

The six full-scale Post-STA conceptual design scenarios are summarized below:

<b>Post-STA Conceptual Design Summary</b>		
<b>Effluent TP Concentration</b>	<b>Diversion of 10-yr POR</b>	<b>Treatment Plant Design Average Daily Flow (mgd)</b>
10 ppb	No diversion	390
	10	260
	20	190
20 ppb	No Diversion	140
	10	100
	20	80

The existing levees would be operated using a maximum water height of 4.5 feet, allowing for four feet of water storage (0.5 to 4.5 feet). The treatment plant would operate at a peak load of 50 percent greater than its average daily design flow rate when the water level within the equalization basin reached 3.5 feet. The table below summarizes the treatment plant operation data and the corresponding FEB water level:

<b>Post-STA Treatment Plant Operation Summary</b>				
<b>Treatment Plant Size (mgd)</b>	<b>% operation During 10-yr POR</b>	<b>% operating time at peak design flow rate</b>	<b>Average depth in FEB (feet)</b>	<b>Days exceedance of 4.0 feet (days/Yr)</b>
390	28	31	1.2	17
260	36	38	1.4	30
190	43	43	1.5	41
140	50	50	1.8	64
100	58	54	2.0	87
80	63	56	2.2	100

### **5.3 PRELIMINARY COST ESTIMATE FOR THE FULL-SCALE CT-SS DESIGN**

**FIGURES 5.5 and 5.6** show the layouts of the full scale Post STA and Post BMP facilities, respectively, within the STA 2 framework. Cost estimates were prepared for the 12 full-scale facility scenarios discussed for CT-SS treatment plants treating Post-BMP and Post-STA waters. **TABLES 5.3 and 5.4** provide summaries of the costs estimates for the different STSOC defined treatment scenarios for the Post BMP and Post STA applications, respectively. Each scenario includes capital, operation and maintenance (O&M), replacement, and salvage costs. A 50 percent present worth cost was then calculated based on a using a net discount rate of 4 percent. The 10-year period of record (1979-1988) flow and phosphorus data was used to calculate the present worth for each scenario per million gallons of treated water (\$/million gallons treated) and per pound of phosphorus removed (\$/pound of P removed). A schematic diagram of the full scale treatment system envisioned for both Post BMP and Post STA applications is provided in **FIGURE 5.7**.

The Basis for Cost Estimates of Full Scale Alternative Treatment (Supplemental) Technology Facilities (August 1999), prepared by B&C for SFWMD, was used to provide various unit costs and is referenced accordingly. These costs were considered as 1998 dollars then converted to 2000 dollars by assuming an average annual inflation rate of 3 percent (Brown and Caldwell, August 1996). Details on the development of costs for the major categories identified in **TABLE 5.3** and **TABLE 5.4** are provided below.

#### **5.3.1 Capital Costs**

***Land Acquisition.*** Land acquisition costs for the residual solids disposal sites were calculated at a price of \$3,500 per acre. An additional 10 percent more land was allowed for easements, right-of-ways, and buffers (Brown and Caldwell, August 1996).

***Influent Pumping Station.*** B&C (August 1999) included a plot of influent/effluent pumping stations unit costs (\$/cfs) against capacity (cfs). FEB and treatment plant influent pump station costs were determined using this cost curve.

***Sludge Treatment and Disposal.*** B&C (August 1996) estimated a base construction cost for sludge treatment and disposal facilities of \$20,000 per mgd of average daily design flow. This cost was developed assuming that sludge thickening in settling ponds followed by underground injection on a dedicated land disposal site.

#### **5.3.2 Contingency Costs**

***Construction Contingencies.*** A 20 % construction contingency cost line item was applied to the all items (Brown and Caldwell, August 1999).



**Engineering, Permitting and Construction Management.** Engineering, permitting and construction management costs were assumed to total 15 percent of construction costs (Brown and Caldwell, August 1996).

### **5.3.3 Operation and Maintenance (O&M) Costs**

O&M costs were developed using vendor supplied information and other sources noted below:

**Pump Stations.** B&C (August 1999) provided O&M costs for two typical pumping stations. Annual O&M costs were based on a flow proportional basis.

**Flow Equalization Basin (FEB).** The flow equalization basins used for the full-scale designs are previously constructed STAs. Therefore, the annual O&M costs were based on STA O&M costs of \$22/acre (Brown and Caldwell, August 1999).

**Chemical Costs.** Chemical costs were estimated based on the pilot studies chemical dosage. Nominal chemical dosages of ferric chloride (40 mg/L as Fe) for Post-BMP and alum (20 mg/L as Al) for Post-STA application were used to calculate chemical costs. B&C (August 1999) provided costs for ferric chloride and alum at \$150 and \$180 per dry ton, respectively.

**Sludge Treatment and Disposal.** The cost of operating and maintaining the sludge treatment and disposal equipment were estimated based on \$1,200 per year per mgd of average daily flow treated at the plant (Brown and Caldwell, August 1996).

**Electric.** Electrical consumption was estimated based on the treatment plant power consumption and a unit cost of \$0.065/kWh (SFWMD).

**Labor.** Labor costs were estimated assuming a staffing plan for 24 hour per day operation and a unit cost of \$30 per hour per employee (includes fringe benefits).

**Treatment Plant Sampling and Monitoring.** It was assumed that sampling and monitoring of the treatment plant would cost approximately \$300,000 per year (Brown and Caldwell, August 1996).

### **5.3.4 Replacement Costs**

The following replacement costs items were used (Brown and Caldwell, August 1999):

- FEB pump stations - 25% of costs replaced once at 25 years;

- Treatment plant pump stations – 50% of costs replaced once at 25 years;
- Chemical feed systems – 60% of costs replaced every 10 years;
- Treatment plant equipment – 25% of plant cost replaced at 20<sup>th</sup> and 40<sup>th</sup> year.

### 5.3.5 Salvage Costs

Salvage estimates were prepared considering both salvage value and salvage costs (Brown and Caldwell, August 1996). These costs include demolition costs, restoration costs, and land value. It was assumed that the land purchased for sludge disposal land was dedicated and no land value or restoration costs were assigned (Brown and Caldwell, August 1996). In all cases, demolition and land restoration costs exceeded the land value (negative net salvage value).

### 5.3.6 Present Worth Analysis

Present worth calculations were performed based on capital and O&M estimates. Estimates of the 50-year present worth for the Post-BMP and Post-STA facilities are summarized below:

<b>Full-Scale Treatment Scenarios</b>		
<b>Present Worth Summary</b>		
<b>Application</b>	<b>Treatment Plant Design Average Daily Flow (MGD)</b>	<b>50-Year Present Worth (\$ million)</b>
Post-BMP	380	312.2
	270	253.0
	200	210.1
	220	230.4
	150	186.8
	120	164.0
Post-STA	390	341.1
	260	257.4
	190	210.7
	140	175.7
	100	145.3
	80	121.7

### 5.3.7 Unit Treatment Costs

The present worth cost with respect to gallons treated and phosphorus removed are summarized below:

Application	Treatment Plant Design Average Daily Flow (MGD)	50-Year Present Worth	
		Dollars per million gallons treated (\$/mgal)	Dollars per pound of phosphorus removed (\$/lb)
Post-BMP	380	112.5	115.5
	270	102.2	108.8
	200	95.9	103.6
	220	92.5	93.4
	150	86.3	88.7
	120	86.3	88.8
Post-STA	390	150.9	298.1
	260	130.0	259
	190	120.7	243.3
	140	113.7	187.5
	100	112.6	181.1
	80	110.2	172.4

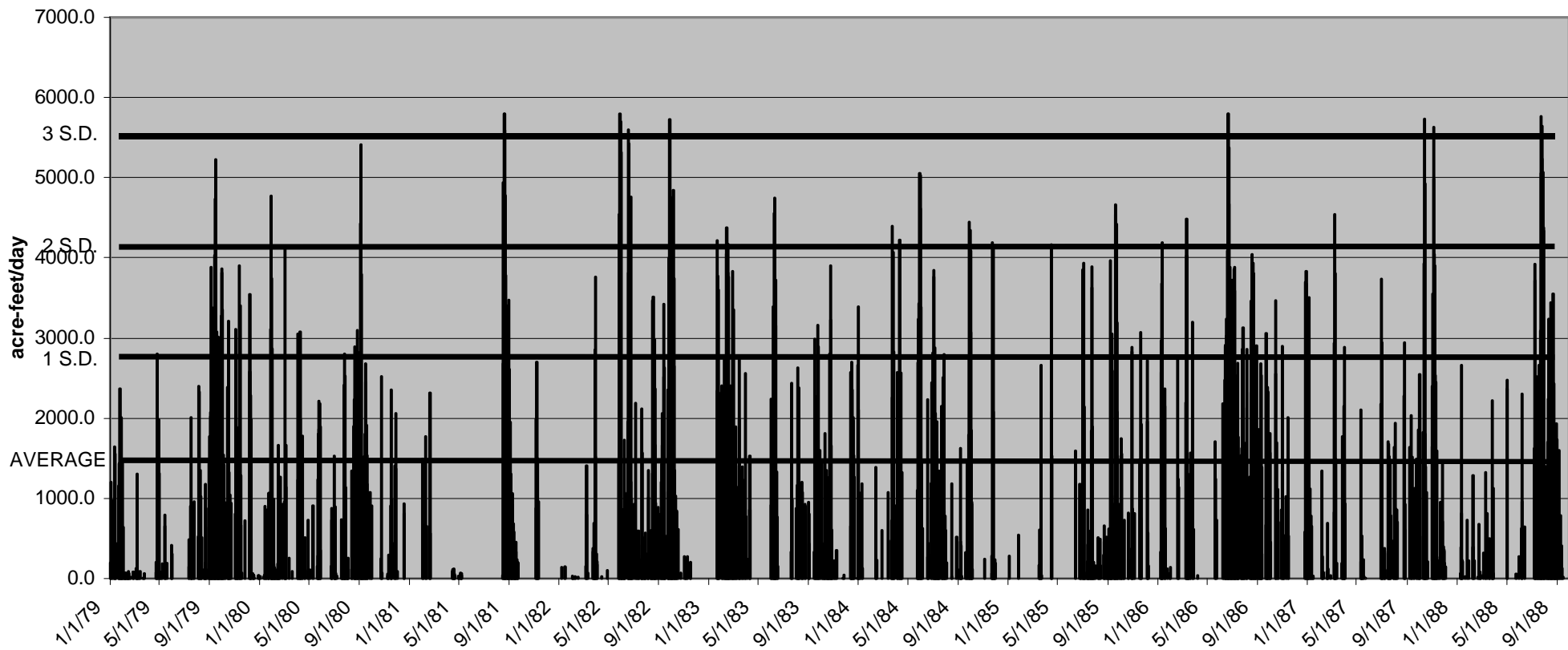
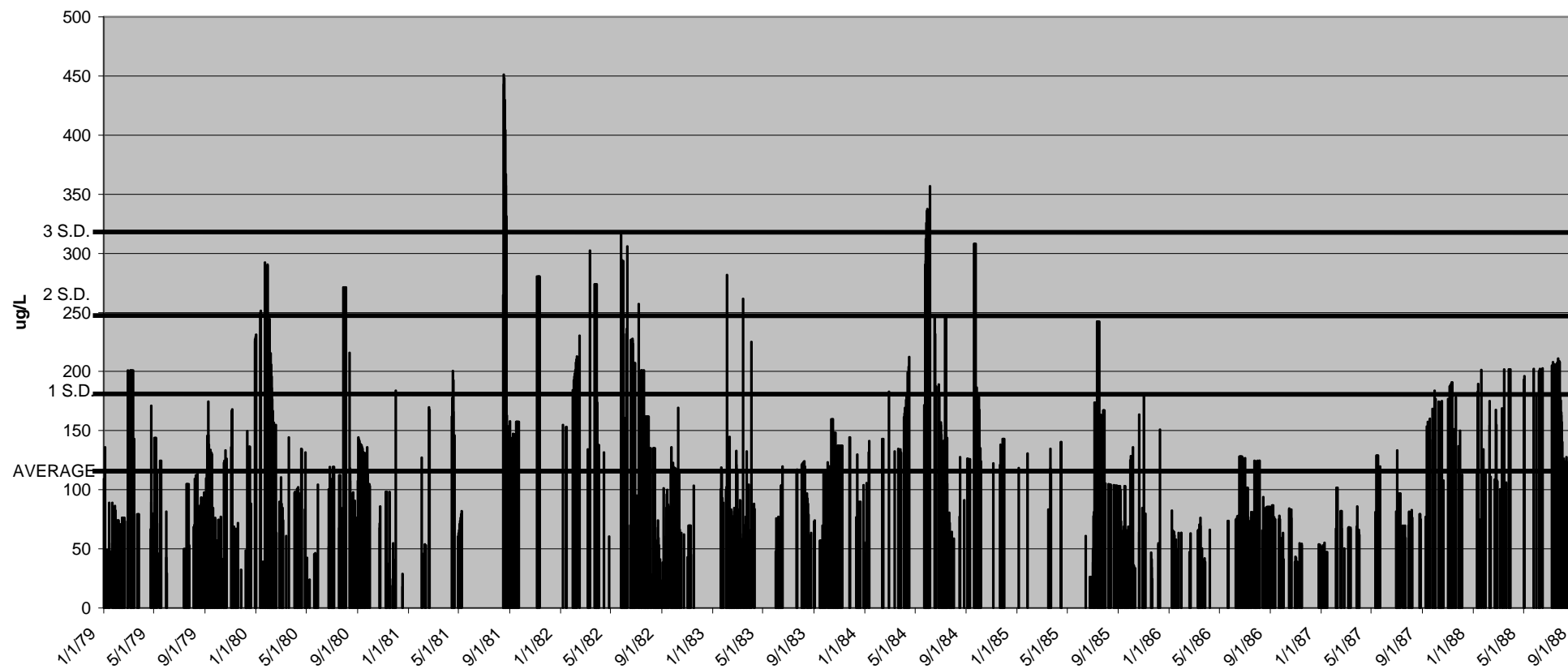


figure 5.1  
BASELINE STA 2 INFLOW (POST BMP) DATA



**figure 5.2**  
**BASELINE STA 2 INFLOW (POST BMP) TOTAL**  
**PHOSPHORUS CONCENTRATION DATA**

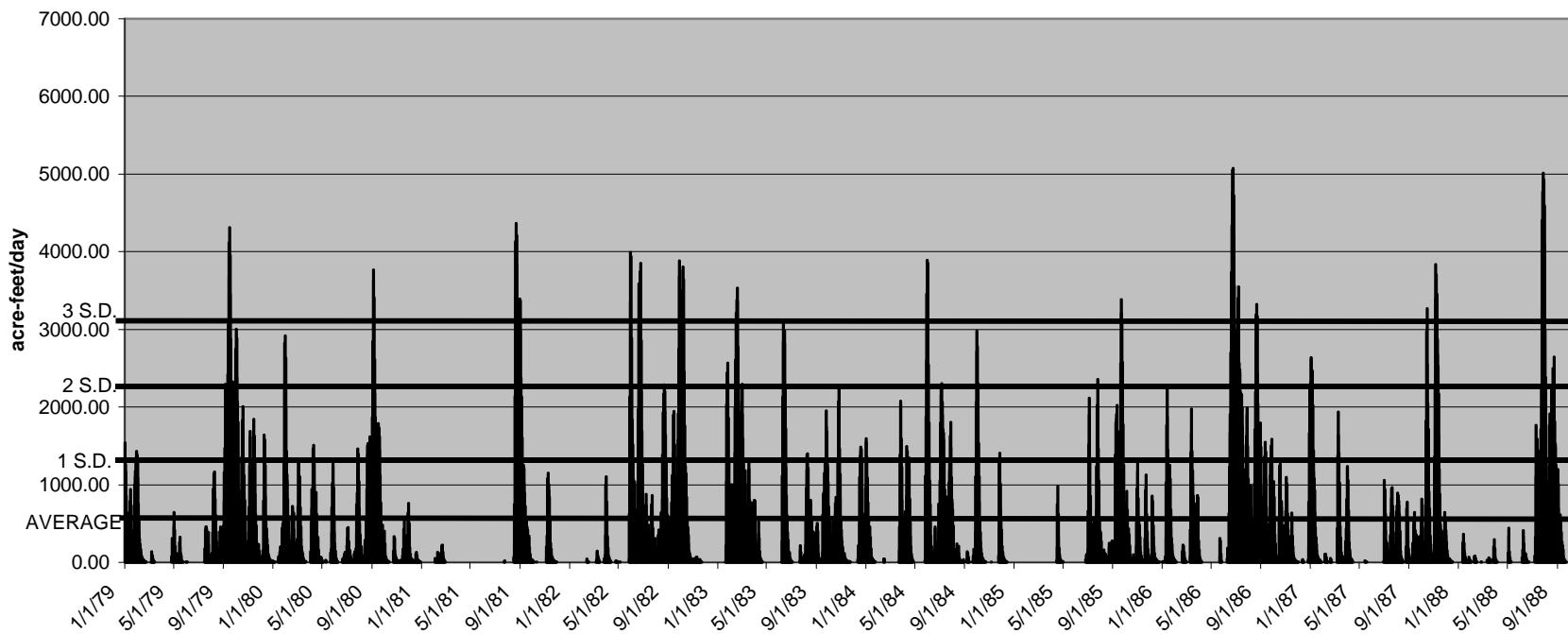
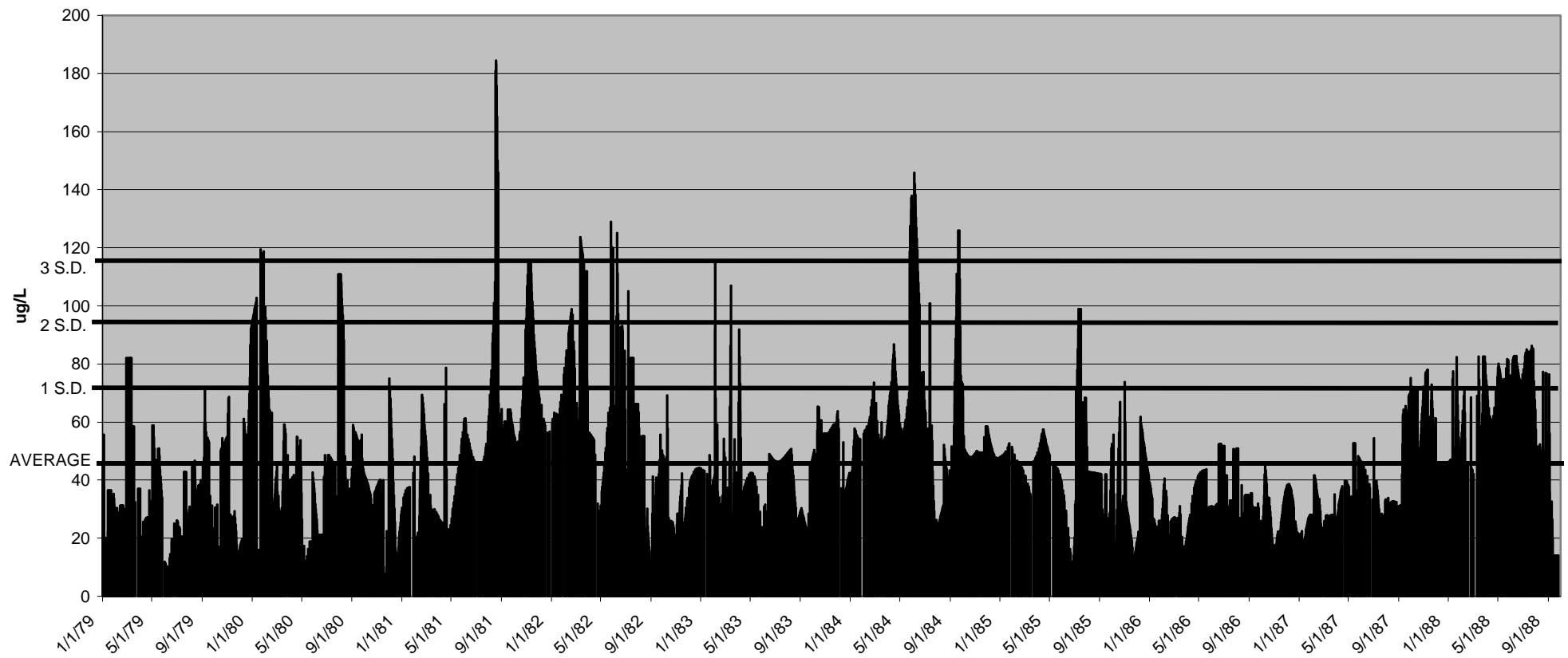
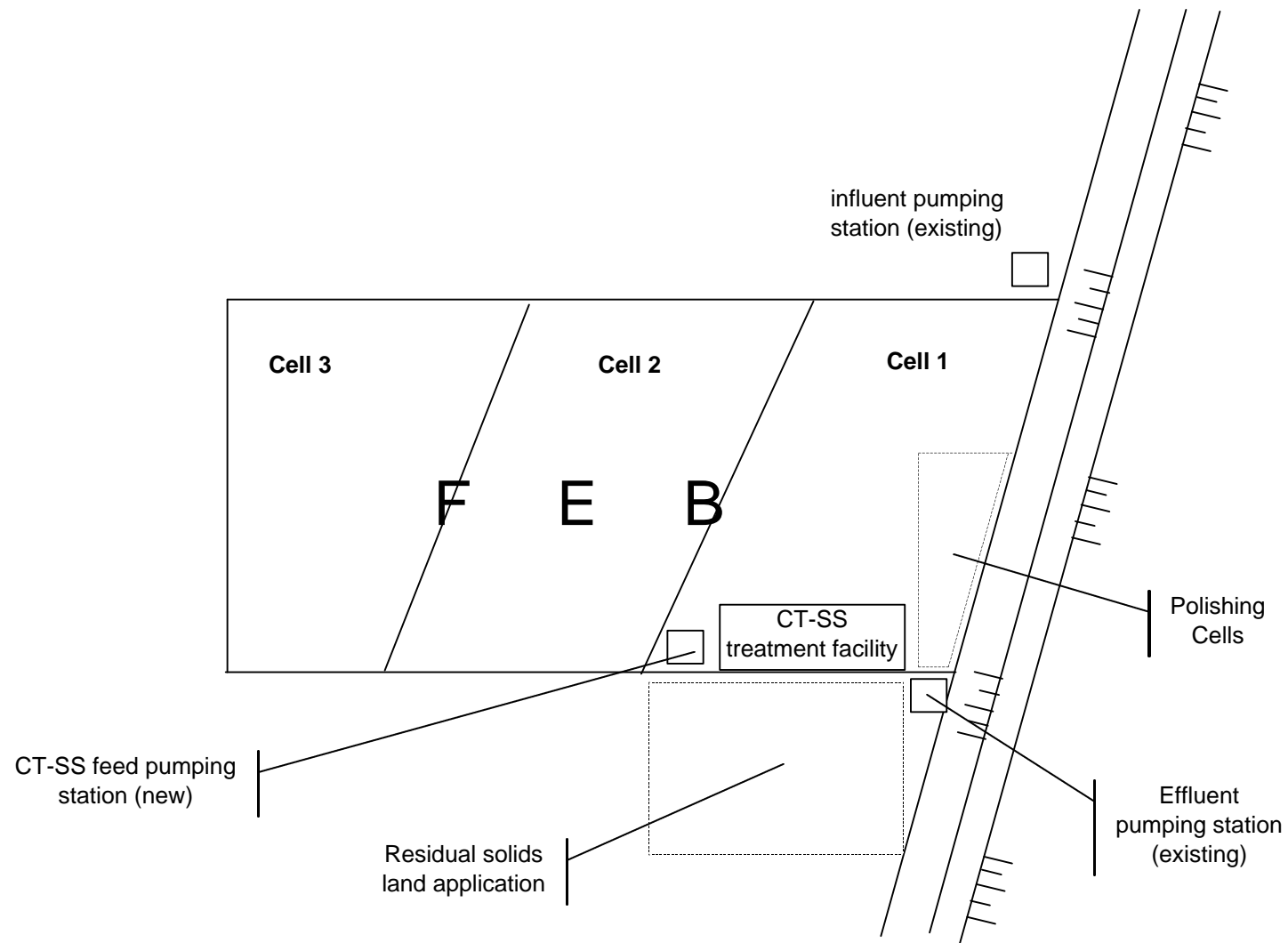


figure 5.3  
ESTIMATED BASELINE STA 2 EFFLUENT FLOW (POST STA) DATA



**figure 5.4**  
**ESTIMATED BASELINE STA 2 EFFLUENT (POST STA)**  
**TOTAL PHOSPHORUS CONCENTRATION DATA**

**FIGURE 5.5**  
**POST-BMP CONCEPTUAL DESIGN SCHEMATIC**





**FIGURE 5.6**  
**POST-STA CONCEPTUAL DESIGN SCHEMATIC**

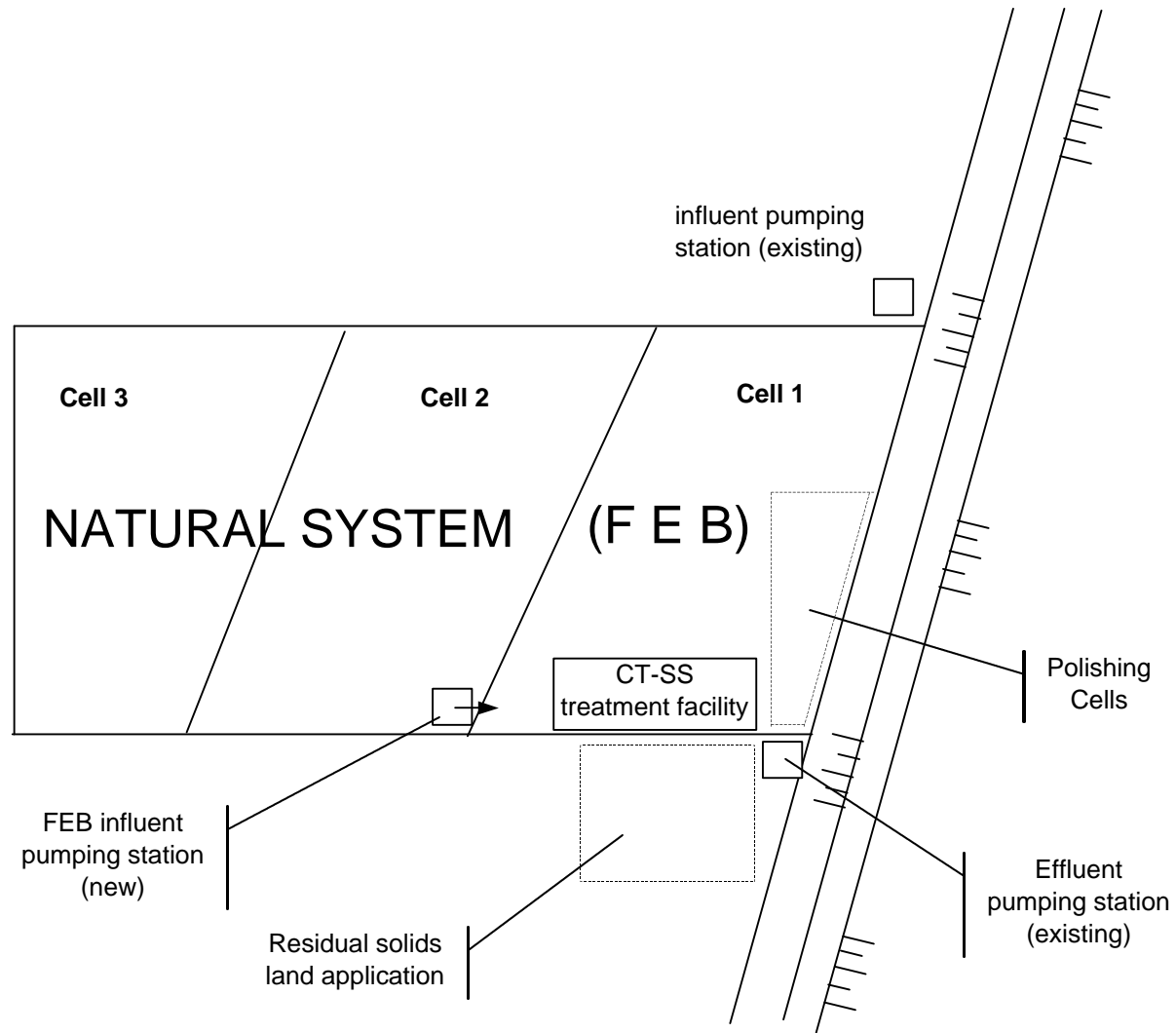
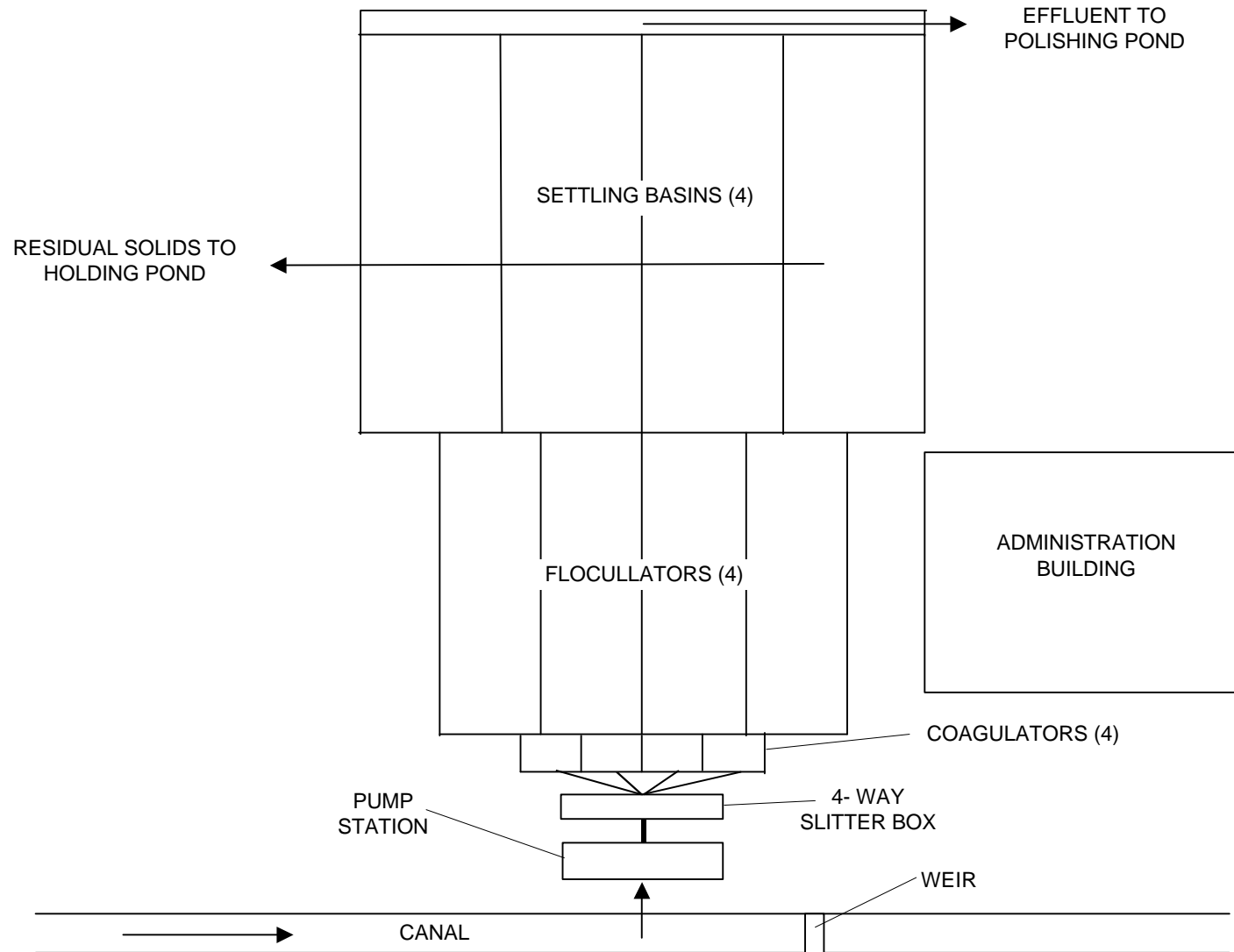


FIGURE 5.7

CONCEPTUAL DESIGN FOR FULL-SCALE POST-BMP AND POST-STA TREATMENT FACILITY



**TABLE 5.1**  
**Post-BMP Water Treatment System – Conceptual Design Criteria**

Design		Plant Design (Average Day) Hydraulic Loading (MGD)					
Criteria	Unit	120	150	200	220	270	380
<b>Feed Characteristics</b>							
Peak Hydraulic Loading	MGD	180	225	300	330	405	570
Average Total Phosphorus Concentration	µg/L	122	122	122	122	122	122
Liquid Phase Temperature Range	°F	68 – 77	68 - 77	68 - 77	68 - 77	68 - 77	68 - 77
<b>Treated Effluent</b>							
Average Total Phosphorus Concentration	µg/L	20	20	10	20	10	10
<b>Flow Equalization</b>							
Surface Area	acres	6,000	6,000	6,000	6,000	6,000	6,000
Usable Depth	feet	4	4	4	4	4	4
Usable Volume	acre-feet	24,000	24,000	24,000	24,000	24,000	24,000
<b>Excavation</b>							
Coagulators	yd <sup>3</sup>	214	283	361	389	480	692
Flocculators	yd <sup>3</sup>	3,851	4,704	6,403	6,936	8,363	11,971
Clarifiers	yd <sup>3</sup>	8,067	9,923	13,443	14,603	17,931	25,091
Flow Control Structure	yd <sup>3</sup>	300	300	300	300	300	300
<b>Reinforced Concrete</b>							
Coagulators	yd <sup>3</sup>	169	210	255	270	320	432
Flocculators	yd <sup>3</sup>	2,095	2,502	3,300	3,548	4,207	5,852
Clarifiers	yd <sup>3</sup>	4,169	5,030	6,644	7,171	8,675	11,878
Flow Control Structure	yd <sup>3</sup>	200	200	200	200	200	200
<b>Raw Water Pumping</b>							
Design Pumping Capacity	MGD	180	225	300	330	405	570
<b>Coagulation</b>							
Velocity Gradient	sec <sup>-1</sup>	1000	1000	1000	1000	1000	1000
Usable Volume	mil gallons	0.14	0.17	0.23	0.26	0.31	0.44
Energy Input	KW	513	658	877	965	1,166	1,658
	HP	687,933	882,378	1,176,057	1,294,065	1,563,606	2,223,378
Units	-	4	4	4	4	4	4
<b>Flocculation</b>							
Hydraulic Detention Time	Min	30	30	30	30	30	30
Gt	-	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5
Usable Volume	mil gallons	2.5	3.1	4.2	4.6	5.6	7.9
Surface Area	Sqft	27,855	34,818	46,424	51,067	62,673	88,206
Energy Input	W	23,035	29,531	39,375	43,313	52,369	74,419
	HP	30,889	39,601	52,802	58,082	70,226	99,796
Units	-	4	4	4	4	4	4
<b>Lamella Settling</b>							
Average Usable Tank Depth	Ft	12	12	12	12	12	12
Clarifier loading rate	Gpm/Ft <sup>2</sup>	0.14	0.14	0.14	0.14	0.14	0.14
Projected plate area	mil sqft	0.74	0.93	1.24	1.4	1.7	2.4
Surface Area	Sqft	58,905	73,590	98,010	107,745	132,330	186,120
Units	-	4	4	4	4	4	4
<b>Chemical Feed System</b>							
Coagulant Type	-	FeCl <sub>3</sub>	FeCl <sub>3</sub>	FeCl <sub>3</sub>	FeCl <sub>3</sub>	FeCl <sub>3</sub>	FeCl <sub>3</sub>
Average Coagulant Dosage	mg/L as metal	40	40	40	40	40	40
Minimum Coagulant Dosage	mg/L as metal	20	20	20	20	20	20
Maximum Coagulant Dosage	mg/L as metal	60	60	60	60	60	60
<b>Waste Handling and Disposal*</b>							
Usable Depth of Holding Cell	feet	4	4	4	4	4	4
Sludge Discharge Frequency	hr <sup>-1</sup>	4 - 8	4 - 8	4 - 8	4 - 8	4 - 8	4 - 8
Hydraulic Detention Time	days	3	3	3	3	3	3
Sludge Holding Pond Volume	acre - feet	6.0	7.2	10.0	11.2	13.2	18.0
Sludge Holding Pond Usable Depth	feet	4	4	4	4	4	4
Sludge Holding Pond Surface Area	acres	1.5	1.8	2.5	2.8	3.3	4.5
Area of Farm Land Application	acres	< 100	< 130	< 170	< 190	< 230	< 330

Notes: \* based on: 1,720 lbs solids per million gallons treated @ 4 percent solids content

**TABLE 5.2**  
**Post-STA Water Treatment System – Conceptual Design Criteria**

Design		Plant Design (Average Day) Hydraulic Loading (MGD)					
Criteria	Unit	80	100	140	190	260	390
<b>Feed Characteristics</b>							
Peak Hydraulic Loading	MGD	120	150	210	285	390	585
Average Total Phosphorus Conc.	µg/L	65	65	65	65	65	65
Liquid Phase Temperature Range	°F	68 - 77	68 - 77	68 - 77	68 - 77	68 - 77	68 - 77
<b>Treated Effluent</b>							
Predicted Total Phosphorus Concentration	µg/L	20	20	20	10	10	10
<b>Flow Equalization</b>							
Surface Area	acres	1,500	1,500	1,500	1,500	1,500	1,500
Usable Depth	feet	4	4	4	4	4	4
Usable Volume	acre-feet	6,000	6,000	6,000	6,000	6,000	6,000
<b>Excavation</b>							
Coagulators	yd <sup>3</sup>	155	193	259	334	449	692
Flocculators	yd <sup>3</sup>	2,563	3,267	4,483	5,891	8,067	12,331
Clarifiers	yd <sup>3</sup>	2,731	3,456	4,704	6,403	8,664	13,067
Flow Control Structure	yd <sup>3</sup>	300	300	300	300	300	300
<b>Reinforced Concrete</b>							
Coagulators	yd <sup>3</sup>	133	157	196	239	303	432
Flocculators	yd <sup>3</sup>	1,468	1,814	2,397	3,061	4,071	6,015
Clarifiers	yd <sup>3</sup>	1,608	1,698	2,576	3,387	4,446	6,472
Flow Control Structure	yd <sup>3</sup>	200	200	200	200	200	200
<b>Raw Water Pumping</b>							
Design Pumping Capacity	MGD	120	150	210	285	390	585
<b>Coagulation</b>							
Velocity Gradient	sec <sup>-1</sup>	1000	1000	1000	1000	1000	1000
Usable Volume	mil gallons	0.09	0.12	0.16	0.22	0.30	0.45
Energy Input	KW	329	430	614	816	1,118	1,723
	HP	441,189	576,630	823,374	1,094,256	1,499,238	2,310,543
Units	-	4	4	4	4	4	4
<b>Flocculation</b>							
Hydraulic Detention Time	Min	30	30	30	30	30	30
Gt	-	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5	1.8E4-1.4E5
Usable Volume	mil gallons	1.7	2.1	2.9	4.0	5.4	8.1
Surface Area	sqft	18,570	23,212	32,497	44,103	60,351	90,527
Energy Input	W	14,766	19,294	27,563	36,619	50,203	77,372
	HP	19,801	25,873	36,961	49,106	67,323	103,756
Units	-	4	4	4	4	4	4
<b>Lamella Settling</b>							
Average Usable Tank Depth	Ft	12	12	12	12	12	12
Clarifier loading rate	Gpm/Ft <sup>2</sup>	0.28	0.28	0.28	0.28	0.28	0.28
Projected plate area	mil sqft	0.25	0.31	0.43	0.59	0.81	1.2
Surface Area	Sqft	19,635	24,585	34,320	46,530	63,690	95,535
Units	-	4	4	4	4	4	4
<b>Chemical Feed System</b>							
Coagulant Type	-	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>
Average Coagulant Dosage	mg/L as metal	20	20	20	20	20	20
Minimum Coagulant Dosage	mg/L as metal	10	10	10	10	10	10
Maximum Coagulant Dosage	mg/L as metal	30	30	30	30	30	30
<b>Waste Handling and Disposal*</b>							
Usable Depth of Holding Cell	feet	4	4	4	4	4	4
Sludge Discharge Frequency	hr <sup>-1</sup>	4 - 8	4 - 8	4 - 8	4 - 8	4 - 8	4 - 8
Hydraulic Detention Time	days	3	3	3	3	3	3
Sludge Holding Pond Volume	acre - feet	3.2	3.2	5.2	6.0	8.0	12.0
Sludge Holding Pond Usable Depth	feet	4	4	4	4	4	4
Sludge Holding Pond Surface Area	acres	0.8	0.8	1.3	1.5	2.0	3.0
Area of Farm Land Application	acres	< 50	< 60	< 80	< 110	< 150	< 220

Notes: \* based on: 1,145 lbs solids per million gallons treated @ 4 percent solids content

Table 5.3  
Full Scale Cost Estimate Summary

10-year POR Flow Volume Diversion	POST BMP					
	10 ppb effluent			20 ppb effluent		
	0%	10%	20%	0%	10%	20%
<b>Basis of Design - Size / capacities</b>						
STA/natural system" area, acres	0	0	0	0	0	0
FEB area, acres	6000	6000	6000	6000	6000	6000
Treatment plant, solids thickening, buffer cell area, acres	430	430	430	430	430	430
Total land area (inside STA-2), acres	6430	6430	6430	6430	6430	6430
Residual solids disposal area, acres	1681	1499	1326	1508	1311	1151
Total land area (outside of existing STA), acres	1681	1499	1326	1508	1311	1151
FEB influent PS capacity, mgd	0	0	0	2	0	0
FEB influent PS average flow, mgd	0	0	0	0	0	0
Treatment plant influent PS capacity, mgd	570	405	300	330	225	180
Treatment Plant influent PS average flow, mgd	380	270	200	220	150	120
<b>Capital Costs, \$ million</b>						
FEB influent pumping station	0.0	0.0	0.0	0.0	0.0	0.0
Treatment plant influent pump station	14.3	11.2	9.0	9.7	7.3	6.1
Treatment plant	40.1	28.3	21.2	23.1	15.8	12.9
Chemical feed system	1.0	0.7	0.5	0.6	0.4	0.3
Residual solids treatment and disposal	7.6	5.4	4.0	4.4	3.0	2.4
Telemetry	0.1	0.1	0.1	0.1	0.1	0.1
Administrative / sampling & monitoring facilities	0.5	0.5	0.5	0.5	0.5	0.5
Subtotal	63.6	46.2	35.3	38.4	27.1	22.3
Construction contingencies (20 percent)	12.7	9.2	7.1	7.7	5.4	4.5
Subtotal, construction costs	76.3	55.4	42.4	46.1	32.5	26.8
Engineering (15 percent)	11.4	8.3	6.4	6.9	4.9	4.0
Land purchase - solids disposal	6.8	6.1	5.4	6.1	5.3	4.7
Total Capital Cost	94.6	69.9	54.1	59.1	42.7	35.5
Present Worth - Capital Cost	94.6	69.9	54.1	59.1	42.7	35.5
<b>O&amp;M Costs, \$ million/yr</b>						
FEB influent pumping station	0.0	0.0	0.0	0.0	0.0	0.0
Treatment plant influent pump station	2.5	1.8	1.3	1.5	1.0	0.8
Chemicals	5.2	4.6	4.1	4.6	4.0	3.5
Maintenance levees	0.1	0.1	0.1	0.1	0.1	0.1
Maintenance FEB	0.1	0.1	0.1	0.1	0.1	0.1
Residual solids treatment and disposal	0.5	0.3	0.3	0.3	0.2	0.2
Electric	0.4	0.4	0.3	0.3	0.3	0.3
Labor	0.7	0.7	0.6	0.6	0.6	0.6
Treatment plant sampling and monitoring	0.3	0.3	0.3	0.3	0.3	0.3
Total Annual O&M Cost	9.8	8.3	7.1	7.8	6.6	5.9
Present Worth - Annual O&M Cost	210.7	178.5	152.7	167.7	141.9	126.9
<b>Present Worth - Replacement Costs, \$ million</b>						
Total Present Worth - Replacement Costs	10.4	7.6	5.8	6.3	4.4	3.6
<b>Salvage Value, \$ million</b>						
Net Salvage value	24.9	20.5	17.4	18.8	15.6	13.9
Present Worth - Salvage Value	3.5	2.9	2.4	2.6	2.2	2.0
<b>50 - Year Present Worth, \$ million</b>						
Capital Cost	94.6	69.9	54.1	59.1	42.7	35.5
O&M Cost	210.7	178.5	152.7	167.7	141.9	126.9
Replacement Cost	10.4	7.6	5.8	6.3	4.4	3.6
Salvage Value	3.5	2.9	2.4	2.6	2.2	2.0
Total	312.2	253.0	210.1	230.4	186.8	164.0
Present worth, \$/million gallons treated	112.5	102.2	95.9	92.5	86.3	86.3
Present worth, \$/pound P removed	115.5	108.8	103.6	93.4	88.7	88.8

Table 5.4  
Full Scale Cost Estimate Summary

10-year POR Flow Volume Diversion	POST STA					
	10 PPB effluent			20 PPB effluent		
	0%	10%	20%	0%	10%	20%
<b>Basis of Design - Size / capacities</b>						
STA/natural system" area, acres	4440	4440	4440	4440	4440	4440
FEB area, acres	1500	1500	1500	1500	1500	1500
Treatment plant, solids thickening, buffer cell area, acres	490	490	490	490	490	490
Total land area (inside STA-2), acres	6430	6430	6430	6430	6430	6430
Residual solids disposal area, acres	911	798	704	623	520	446
Total land area (outside of existing STA), acres	911	798	704	623	520	446
FEB influent PS capacity, mgd	585	390	285	210	150	120
FEB influent PS average flow, mgd	390	260	190	140	100	80
Treatment plant influent PS capacity, mgd	585	390	285	210	150	120
Treatment Plant influent PS average flow, mgd	390	260	190	140	100	80
<b>Capital Costs, \$ million</b>						
FEB influent pumping station	11.7	8.8	7.0	5.5	4.3	3.6
Treatment plant influent pump station	14.5	10.9	8.7	6.9	5.3	4.5
Treatment plant	23.5	15.5	11.5	8.5	6.4	5.0
Chemical feed system	0.6	0.4	0.3	0.2	0.2	0.1
Residual solids treatment and disposal	7.8	5.2	3.8	2.8	2.0	1.6
Telemetry	0.1	0.1	0.1	0.1	0.1	0.1
Administrative / sampling & monitoring facilities	0.5	0.5	0.5	0.5	0.5	0.5
Subtotal	58.7	41.4	31.9	24.5	18.8	15.4
Construction contingencies (20 percent)	11.7	8.3	6.4	4.9	3.8	3.1
Subtotal, construction costs	70.4	49.7	38.3	29.4	22.6	18.5
Engineering (15 percent)	10.6	7.5	5.7	4.4	3.4	1.8
Land purchase - solids disposal	3.7	3.2	2.9	2.5	2.1	1.8
Total Capital Cost	84.7	60.3	46.9	36.3	28.0	22.1
Present Worth - Capital Cost	84.7	60.3	46.9	36.3	28.0	22.1
<b>O&amp;M Costs, \$ million/yr</b>						
FEB influent pumping station	2.0	1.3	1.0	0.7	0.5	0.4
Treatment plant influent pump station	2.6	1.7	1.3	0.9	0.7	0.5
Chemicals	4.9	4.2	3.7	3.3	2.8	2.4
Maintenance levees	0.1	0.1	0.1	0.1	0.1	0.1
Maintenance FEB	0.1	0.1	0.1	0.1	0.1	0.1
Residual solids treatment and disposal	0.5	0.3	0.2	0.2	0.1	0.1
Electric	0.3	0.3	0.2	0.2	0.2	0.1
Labor	0.7	0.7	0.6	0.6	0.6	0.6
Treatment plant sampling and monitoring	0.3	0.3	0.3	0.3	0.3	0.3
Total Annual O&M Cost	11.5	9.0	7.5	6.4	5.4	4.6
Present Worth - Annual O&M Cost	247.3	193.5	161.3	137.6	116.1	98.9
<b>Present Worth - Replacement Costs, \$ million</b>						
Total Present Worth - Replacement Costs	12.0	5.9	4.5	3.5	2.6	2.1
<b>Salvage Value, \$ million</b>						
Net Salvage value	20.6	16.5	14.1	12.2	10.6	9.5
Present Worth - Salvage Value	2.9	2.3	2.0	1.7	1.5	1.3
<b>50 - Year Present Worth, \$ million</b>						
Capital Cost	84.7	60.3	46.9	36.3	28.0	22.1
O&M Cost	247.3	193.5	161.3	137.6	116.1	98.9
Replacement Cost	12.0	5.9	4.5	3.5	2.6	2.1
Salvage Value	2.9	2.3	2.0	1.7	1.5	1.3
Total	341.1	257.4	210.7	175.7	145.3	121.7
Present worth, \$/million gallons treated	150.9	130.0	120.7	113.7	112.6	110.2
Present worth, \$/pound P removed	298.1	259.0	243.3	187.5	181.1	172.4